

# MONTHLY WEATHER REVIEW.

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## INTRODUCTION.

This REVIEW for October, 1893, is based on reports from 3,146 stations occupied by regular and voluntary observers. These reports are classified as follows: 159 reports from Weather Bureau stations; 40 reports from United States Army post surgeons; 2,121 monthly reports from state weather service and voluntary observers; 29 reports from Canadian stations; 217 reports through the Southern Pacific Railway Company; 500 marine reports through the co-operation of the Hydrographic Office, Navy Department, and "New York

Herald Weather Service"; 154 weekly reports from 39 U. S. Life-Saving stations; 41 reports from navigators on the Great Lakes; monthly reports from local services established in all states and territories; and international simultaneous observations. Trustworthy newspaper extracts and special reports have also been used.

The WEATHER REVIEW for this month has been prepared under the general editorial supervision of Prof. Cleveland Abbe.

## CHARACTERISTICS OF THE WEATHER FOR OCTOBER, 1893.

### LOW AREAS.

The principal areas of low pressure have been those attending the hurricane of the 1st and 2d in Louisiana and that which passed from the middle Atlantic October 1st to the south Atlantic coast October 12th, and thence northward over the lower lake region on the 14th; finally the depression attending the whirlwind that formed on the 21st north of the Bahamas and disappeared in Maryland on the 23d.

The first of these storms was remarkably severe and destructive over a small region in southern Louisiana and Alabama, and a great loss of life was caused by the high water that attended it.

The second was barely felt in the West Indies, as its track lay to the north of those islands; at Nassau the wind attained a storm velocity; on the coasts of Georgia, Florida, and South Carolina the storm was very severe and the ocean water rose to an unusual height; after reaching the lower lake region the storm was again very severe, being in most

places considered as the severest that has been experienced on the Lakes for many years.

### TEMPERATURE.

The average temperature was in excess from 4 to 7 in the lower Saint Lawrence valley, New Brunswick, and Cape Breton, and to a less extent as we proceed westward to the upper Mississippi and lower Missouri valleys and southward to the middle Atlantic states. The temperature was below the normal about 4 or 5 in central Oregon and Washington, Assiniboia, and Manitoba and southward to the south Atlantic and Gulf States and California.

### PRECIPITATION.

The precipitation was largely in excess of the normal over the northern plateau and north Pacific coast regions. It was decidedly below the normal over the middle and southern plateau, the south Pacific coast, the middle and southern Rocky Mountain slopes, western Gulf states, and Missouri Valley regions.

## ATMOSPHERIC PRESSURE (expressed in inches and hundredths).

The distribution of mean atmospheric pressure reduced to sea-level for October, 1893, as determined from observations taken daily at 8 a. m. and 8 p. m. (75th meridian time), is shown by isobars on Chart II, which also gives the so-called prevailing winds, or those most frequently observed at each station.

The normal distribution for October of atmospheric pressure and the direction of the normal wind resultant for each station is shown on Chart V. This chart has been prepared by Prof. H. A. Hazen, who has also prepared all the others of this series preliminary to the publication by the Weather Bureau of specially prepared data and charts showing the meteorological and climatic features and conditions of the United States. The pressures for both Canada and the United States are reduced to sea-level but not to standard gravity by Prof. Hazen's methods and formulæ. The wind resultants are as given by him at page 124 of his "Meteoro-

logical Tables," and are computed by Lambert's formula, giving equal weight to each observed wind without regard to its velocity.

As compared with the preceding month of September the mean pressure for October, 1893, is slightly lower in the upper lake region and the extreme south Atlantic coast, the maximum change being a fall of .09 at Jupiter Inlet, elsewhere the pressures have generally risen; the rise is .15 or more throughout the Rocky Mountain region, the maximum being .20 at Salt Lake City. A decided rise has also occurred in Maine and the Gulf of Saint Lawrence, the maximum being a rise of .15 at Grindstone Island in the Gulf of Saint Lawrence.

As compared with the normal for this month the pressures for October, 1893, have been in excess in the middle Atlantic states, New England, New Brunswick, and Nova Scotia, the maximum being from .08 to .10 in the latter provinces. Pressure has also been in excess, but to a less extent, over Texas,

the Rocky Mountain plateau, and the Pacific coast. Pressure has been below the normal in the eastern Gulf and south Atlantic states, the Ohio, Missouri, and Mississippi valleys, the Lake region, and thence to Saskatchewan; the maximum deficit is from .07 to .09 over Lake Superior and Manitoba.

#### HIGH AND LOW AREAS.

The paths of the centers of high and low areas moving over the United States and neighboring regions are shown on Charts IV and I, respectively, and their principal characteristics are described by the editor in the following text and tables. The attention of the reader is called to the fact that the movement of these so-called centers is not synonymous with the movement of the atmosphere as such. The highest pressure in a high area, like the lowest pressure in a low area, is a *locus* or place at which certain effects are produced by the movement of the air, which effects are combined with the static pressure that would prevail if the air were not in motion. Just as the movement of a cloud or a wave has but a secondary relation to the movement of the air or the water within them, so the movement of the high pressure is the result of a much more rapid movement of the upper air as it descends and strikes against the earth's surface. Centers of high pressure, like those of low pressure, may remain stationary while the individual particles of air are moving within them with great rapidity. A general depression may have several centers of minima, and a general elevation may have several centers of maxima; the movement of the whole region of elevation or depression may differ from the movement of the centers of high or low within them, the latter being usually more rapid than the former; the movement of centers differs from that of the air within them, being usually slower.

#### HIGH AREAS.

I.—This is a continuation of No. IX of September, which now moved eastward and disappeared on the 3d north of the Saint Lawrence.

II.—This is a continuation of No. X of September, and on the morning of the 1st was central on the coast of Oregon. The area of rising pressure extended rapidly southeastward and on the morning of the 3d a small excess of pressure was central in northern Texas and a remnant of the area still remained on the coast of Oregon and northern California, while a region of low pressure had extended in between, coming from the north and the south simultaneously on the afternoon of the 2d. This remnant on the Pacific coast must be considered as the eastern edge of the large area of high pressure over the Pacific Ocean.

III.—The remnant of high pressure just spoken of pushed eastward on the 4th while depression No. VI was developing on the eastern slope of the Rocky Mountains far to the southward of the center of low No. IV. This must again be considered as a southeastward movement of the upper atmosphere over the Pacific high area and in response to the deficit on the eastern slope. We must conceive of these upper layers as representing air that is flowing from the equatorial regions northeastward but cooling by radiation and settling downward and ready at any moment to slide down along the steepest available gradient to the earth's surface, while at the same time the resistances of that surface impart to the descending air the centrifugal tendency that drives it back again toward the equator; thus the northeastern flow of the upper air is converted into a southeast flow (or a northwest wind) when this cold, dry air reaches the earth's surface. In general any region of cold, dry northwest winds at the earth's surface represents the first stage of the return toward the equator of air that a short time before had been flowing from the equator as an upper current. As soon as the surface resistances have diminished the surplus energy of the northwest wind it becomes a northerly, and soon after that a northeast

wind, and merges into the general northeast trades of the tropics.

IV.—On the north side of low No. III there followed a slight barometric rise, the center of which was located in Virginia on the morning of the 5th; it was at Cape Cod on the morning of the 6th, and off Nova Scotia on the morning of the 7th.

V.—On the morning of the 9th, and in the rear of low No. VIII, the barometer was high in Manitoba while low No. IX was developing over the northern plateau region. This high moved southeastward, and by the morning of the 10th had merged with high No. III. On the 12th it was central southeast of New England, after which it disappeared.

VI.—This area originated in a manner similar to that of Nos. II and III; the extensive area of low pressure (IX) prevailed over the eastern slope on the 10th, and an area of high pressure moved northeastward over Oregon and northern California into Alberta, Assiniboia, and Manitoba, being central in Idaho on the morning of the 11th. The upper air represented by this rapid advance must have become rapidly dissipated in its circulation around the three areas of low pressure, Nos. IX, VI, and XIV, so that on the morning of the 12th this high pressure extended as a narrow ridge from Oregon southeast to Colorado, and thence northeast to Minnesota and beyond; the maximum barometric departures from normal were at that time at Salt Lake City, Utah, Winnemucca, Nev., Eureka, Cal., and Roseburg, Oregon.

VII.—The retreat of the Pacific high area on the 12th, as just described, was immediately followed by a decided advance on the 13th, at which time the highest pressure was central in western Montana. The barometer at that time was very generally below the normal over the region east of the 100th meridian under the influence of the hurricane (low No. X), and so continued during the next day, consequently a great flow toward the southeast occurred. On the morning of the 13th the area of high pressure extended from Saskatchewan to Texas, covering the whole Rocky Mountain region and Pacific slope. On the morning of the 14th its eastern boundary had moved eastward to Minnesota and Mississippi; the western boundary extended from Yuma northward to the middle of British Columbia, but within this region the area of greatest barometric departure covered eastern Colorado and western Nebraska, having moved rapidly southeastward.

On the morning of the 15th the highest pressure was central in Arkansas, and an extensive area of frost prevailed thence eastward to South Carolina, northeastward to Lake Michigan, and northwestward to central Kansas, where, however, frost had also prevailed on the 13th. This is a remarkable illustration of the general rule that frosts, which depend essentially on the radiation upwards through a perfectly clear sky, are liable to be especially severe on the north and east sides of the center of a high area. On the morning of the 16th pressure was highest in West Virginia, and frost prevailed throughout the interior of the south Atlantic and Gulf states, southwest Virginia, Ohio, Michigan, Illinois, Arkansas, and north-eastern Texas; the included area being, therefore, principally on the southeast, southwest, and northwest sides of the central high.

On the morning of the 17th the pressure was highest in western Pennsylvania and western Virginia and the frost area prevailed from North Carolina and Tennessee northeastward to New York and Maine, being quite symmetrical with regard to the central high. On the morning of the 18th the greatest departures from the normal were in the lower Saint Lawrence valley, while the subsidiary high remained central in western Virginia. This reinforcement at the north was evidently due to the influx of air from farther north, as shown by the northerly winds in Canada, and constituting essentially a new area of high pressure, No. VIII.

VIII.—This area descended in the early morning of the 18th southward into the Saint Lawrence Valley and joined No. VII on the 19th over New England. On the morning of the 20th pressure was highest off the coast of New England.

IX.—While low area No. XII was moving southeastward over Alberta into Montana on the 15th, the circulation around the low area of the Aleutian Islands drew the high area from the Pacific Ocean again northeastward, and by the morning of the 16th it was pushing over the coast of Oregon into Nevada, and by the morning of the 17th pressure was highest on the coast of Washington and British Columbia. This area then stretched as a long ridge southeastward over Idaho and Wyoming, where it was central on the 18th and 19th, respectively, to Texas, which it reached on the morning of the 20th, at which time pressure was above the normal at every station with one or two exceptions on the U. S. weather map. There had evidently been a general movement of the air in the upper strata, which is only faintly indicated by the movement of the central highest pressure. In general, the high pressures are as much the results of atmospheric movement as are the low pressures, and like them do not represent static conditions. The change in the isobars on the 18th–21st argues for the existence of a general descending current producing high pressures throughout the United States, but the highest pressures were not necessarily in the center of the whole region.

On the morning of the 20th the ridge of high pressure extended from British Columbia to the coast of Texas; the highest pressures of area No. IX still remained in Wyoming and western Montana, while the equally high pressures of area No. VIII existed at the same time on the coast of New England. During the rest of the day the ridge over the Rocky Mountain plateau was broken up and replaced by low area No. XIII. The upper air evidently moved eastward, and on the 21st the morning pressure was high in Arkansas and also on Lake Superior. The latter region of high pressure represents the northern portion of the extensive area of October 20th, which had now, by its southeastward motion, come into the limits of our maps. The southern end rapidly dissipated, but the northern end was on the morning of the 23d southeast of Nova Scotia and on the morning of the 24th south of Newfoundland. The development of this high area during the 19–20th bespeaks the existence at that time of an area of low pressure on either the Pacific or the Gulf coast of Mexico, or possibly in the Caribbean Sea, out of which low area No. XV was developed.

X.—On the 23d low area No. XVI prevailed on the eastern slope of the Rockies, and again pressure rose on the Pacific coast, extending rapidly over the Rocky Mountain plateau. On the 23d, in the afternoon, pressure was highest in Washington; on the 24th, in the morning, a ridge of  $+0.12$  excess above the normal extended from Washington southeast over New Mexico; this slight ridge divided into southeast and northwest portions, so that on the morning of the 25th a high area was central in Lower Michigan, while the remaining high area continued in Oregon. On the morning of the 26th the former branch was central in the Saint Lawrence Valley, while the latter stretched southeastward towards Utah.

On the 27th, in the morning, the Saint Lawrence branch had passed southeast to the coast of Nova Scotia, and the Oregon branch was central near Salt Lake City, Utah, but with an advanced area of high pressure in Texas, so that a ridge again extended from Oregon southeast to Texas; at the same time a decided movement southeastward into Alberta had produced a new central high pressure in that region. The ridge from Utah to Texas and the area in Alberta must be considered as branches from the larger Pacific area off the coast of Oregon and British Columbia. During the 27th the northernmost of these areas moved rapidly southeast, while

the southernmost remained nearly stationary, and on the morning of the 28th there was a ridge extending from Saskatchewan due south into Texas, whose highest pressures were then in North and South Dakota, but whose highest departures from normal were in Manitoba and Assiniboia.

This region of high pressure moved rapidly southward; it was central in southern Minnesota on the morning of the 29th, in southern Indiana on the morning of the 30th, and in eastern Pennsylvania on the morning of the 31st. Light frosts were reported on its southeastern side in Texas and Arkansas on the morning of the 27th; in Louisiana and Mississippi on the morning of the 28th; in Tennessee, Alabama, North Carolina, Arkansas, and Mississippi on the morning of the 29th, as also at Rochester, N. Y. On the morning of the 30th frost was again reported from the preceding states, and in addition from Virginia, Maryland, Pennsylvania, New Jersey, New York, and Massachusetts. Finally, on the morning of the 31st frost prevailed at most stations in Alabama, Georgia, North Carolina, and South Carolina, as well as in the interior of those states, and was also reported from Eastport, Me. From this date, by virtue of this frost, the yellow fever on the south Atlantic coast at Brunswick, Ga., diminished.

The ridge of high which lay nearly northwest and southeast on the 26th and nearly north and south on the 28th had by the 31st come to trend northeast and southwest from North Carolina to the mouth of the Saint Lawrence, thus illustrating a general principle that eastward motions in the upper layer of the atmosphere are more rapid at latitude  $50^\circ$  than at latitude  $30^\circ$ ; in the present case the eastward movement from the 27th to the 31st was about 1,000 miles at latitude  $30^\circ$ , and 2,200 miles at latitude  $50^\circ$ .

Movements of centers of areas of high and low pressures.

Number.	First observed.			Last observed.			Path.		Average velocities.	
	Date.	Lat. N.	Long. W.	Date.	Lat. N.	Long. W.	Length.	Duration.	Daily.	Hourly.
<b>High areas.</b>										
I.....	1, a. m.	47	79	3, a. m.	48	71	Miles. 450	Days. 2.0	Miles. 225	9
II.....	1, a. m.	45	125	3, a. m.	33	102	1,500	2.0	750	31
III.....	4, a. m.	42	125	9, a. m.	35	36	2,500	5.0	500	21
IV.....	5, a. m.	37	78	7, a. m.	43	65	800	2.0	400	17
V.....	9, a. m.	51	96	14, a. m.	43	62	1,900	5.0	380	16
VI.....	10, a. m.	37	123	11, a. m.	43	112	700	1.0	700	29
VII.....	12, a. m.	43	123	18, a. m.	39	78	2,900	6.0	483	20
VIII.....	18, a. m.	47	73	20, a. m.	42	67	600	2.0	300	12
IX.....	16, a. m.	44	127	24, a. m.	46	57	4,600	8.0	575	24
X.....	23, p. m.	47	120	27, a. m.	44	65	3,300	5.0	825	34
Mean.....									514	21
<b>Low areas.</b>										
I.....	30, a. m.	38	101	2, p. m.	52	87	1,100	3.5	314	13
II.....	1, p. m.	28	92	4, p. m.	36	74	1,300	3.0	433	18
III.....	2, a. m.	53	113	4, p. m.	52	90	1,000	2.5	400	17
IV.....	3, a. m.	38	86	3, p. m.	42	82	300	0.5	.....	.....
V.....	4, p. m.	37	103	7, a. m.	49	81	1,400	2.5	520	22
VI.....	5, p. m.	51	115	7, a. m.	53	96	900	1.5	600	25
VII.....	7, a. m.	51	126	10, a. m.	47	62	2,700	3.0	900	38
VIII.....	8, p. m.	42	113	12, p. m.	37	87	2,500	4.0	625	26
IX.....	5, a. m.	20	50	15, p. m.	56	60	4,400	10.5	419	17
X.....	11, a. m.	51	125	12, p. m.	53	99	1,100	1.5	733	30
XI.....	14, p. m.	52	116	18, a. m.	51	96	1,500	3.5	428	18
XII.....	20, p. m.	51	117	22, a. m.	49	88	1,400	1.5	933	39
XIII.....										
XIV.....	21, p. m.	27	76	23, p. m.	39	78	950	2.0	475	20
XV.....	22, a. m.	40	118	25, a. m.	51	65	3,300	3.0	1,000	42
XVI.....										
XVII.....	25, p. m.	59	114	29, a. m.	51	60	2,500	3.5	714	30
XVIII.....	29, p. m.	65	110	31, p. m.	53	92	1,050	2.0	525	22
XIX.....										
Mean.....									601	25

#### LOW AREAS.

The paths of the centers of low pressure during the month of October, 1893, are traced on Chart I, and present examples of several types of disturbances: (1) those that pass southeastward over the Rocky Mountains from the northern portion of the Pacific Ocean and move eastward over our northern boundary to the Maritime Provinces of Canada; (2)

those that move much farther southeastward toward Colorado and thence northeast down the valley of the Saint Lawrence; (3) those that apparently originate out of the ill-defined low area whose easterly arm stretches northeastward over Arizona, and which becoming isolated from it by high pressures advancing from the north, develop into low areas on the eastern slope of the Rocky Mountains; (4) the hurricanes that develop in the Gulf of Mexico, Campeche, Honduras, and the Caribbean Sea; and (5) the so-called West Indian hurricane that originates at an unknown distance east of the Windward Islands. In detail these storms are as follows:

I.—The location of this storm center is rather uncertain; it moved on the 1st and 2d northeastward off the coast of Nova Scotia and Newfoundland; this is evidently only a portion of the track of the hurricane that had come up from the Atlantic, and is a continuation of the low numbered XII in the September REVIEW.

II.—On October 1st an extensive depression extended from Manitoba southward over Texas into the Gulf; the northern end of this depression centered in a region which we have called low area No. II. The southern end of this depression constituted low area No. III. No. II moved northeast and disappeared on the 2d near James Bay.

III.—This so-called Gulf hurricane advanced suddenly and unexpectedly northeastward over southeastern Louisiana on the afternoon of the 1st. The early history of this storm, like that of low No. XV, is almost entirely unknown to us at present, but it is plausible that the areas of high pressure that were pushing southward into the Gulf before these storms themselves appeared argue for the existence of a preceding low pressure much farther south, say on the coast of Mexico and Honduras. On the other hand, there often exists on the southern edge of an area of high pressure a long trough of low pressure, at any point of which a whirl may suddenly begin and thence rapidly grow into a storm; this evidently occurred in connection with lows No. XIII and XVI, and very probably explains the sudden appearance of the low No. XV on the afternoon of the 21st. With regard to low No. III, the general distribution of wind at stations along the Gulf coast would suggest that there could have been no antecedent extensive whirlwind system, and that this storm, that was so terribly destructive over a very limited region, had only existed since the morning of the 1st, and had only grown to the size of the largest tornado when it struck the coast of Louisiana.

The observer at New Orleans, La., reports:

October 1st, a severe and destructive storm began about 6.30 p. m., continuing through the night. Much damage was caused throughout the city. About 2,000 lives were lost along the Gulf coast south and east of this section. The storm was severest in the Louisiana Delta and in the Plaquemines Parish, where it was attended with great loss of life and property. A velocity of 48 miles per hour was recorded in the city at 8.20 p. m., after which the record was lost, owing to the anemometer getting out of order. A velocity of 65 miles was attained at West End, when the instrument became unserviceable.

Mr. Kerkam, as Secretary of the Louisiana State Weather Service, reports:

No complete record of the wind velocity or rainfall of the storm can be obtained, since all instruments in the path of the hurricane were blown down, and in the case of Port Eads destroyed. It is evident, however, that the wind must have blown at the rate of 100 miles per hour in the vicinity of Pointe-a-la-Hache and along the islands on the coast. While the wind worked great havoc, yet the immense wave of water that swept over the devastated section engulfed and swept away everything in its path. It is probable that the center of this hurricane passed midway between New Orleans and Port Eads on its northeast course, since the path of greatest destruction was in that neighborhood.

It is said that over 1,500 lives were lost on the coast by drowning; the destruction of property, and the orange, rice, and other crops was very complete.

Crossing Louisiana in a northeasterly direction, the center struck the coast of Mississippi a little west of the Alabama

boundary line. The following description by one who must have been very near the center is from Capt. Henry M. Davies, of the schooner "B. Frank Neally," lying at anchor at Moss Point, Miss., N. 30° 25', W. 88° 34':

I awoke and found it blowing heavy from east-southeast, barometer 29.90. (During October 1, 1893, the barometer was 29.90, and it was raining all day, with but little wind from the southeast.) I went and looked at the glass and found it at 29.70. I called the mate and told him that we were going to have a gale, the vessel at the time lying at the lumber wharf. We doubled our lines at 5 a. m.; the wind came in gusts and rain 6 a. m.; carried away head lines and dropped anchor, glass at the time 29.30; wind southeast by east, time 7 a. m.; got a hawser from starboard bow on shore. By that time the stern lines gave way, glass 29.00; no change in the wind. At 8 a. m. we were riding to two hawsers from shore and one anchor, glass 28.85, and the weather continued to blow heavier and heavier, glass 28.65, until 9.30 a. m., 90th meridian time, or railroad time, and it abated nearly to calm and gradually went around by south to southwest, and it came out heavy from west-southwest and west at 11 a. m., and continued until 3 p. m. and cleared away. It never went north of west until some time during the night. Nearly calm at 8 p. m.

The observer at Mobile reports:

Rain began 8.25 p. m. of the 1st, with rapidly falling barometer, and by 11 a. m. of the 2d a heavy southeast gale was blowing. The extreme velocity of the wind several times reached 80 miles. The rain continued throughout the day, ending at 7.30 p. m. At 2.15 p. m. the barometer began to rise, and at 2.30 began to rise as rapidly as it had fallen. Great damage was done to property. The prostrated trees lay in one general direction from southeast and south. The water was 4 inches higher than in 1852, the severest of any previous storm recorded. In the marsh truck farm section nearly every house was swept away, and farms were destroyed in Mobile County. Seven lives were reported lost.

The same observer communicates to the "Mobile Register" of October 3d an historical summary, from which we quote the following:

The first storm, accompanied by a high flood in Mobile Bay, was in 1711, when the water overflowed the newly organized town and caused its removal to the present site. 1711, September 11-13, a hurricane destroyed churches and buildings in New Orleans, and was felt at Mobile. 1732, a destructive hurricane. 1740, September 12, a destructive hurricane, lasting 12 hours, from the mouth of the Mississippi to Pensacola. 1746, hurricane on the Gulf coast. 1772, August 31 to September 3, most destructive storm as yet experienced; vessels, boats, and logs driven into the heart of Mobile; sea rose to a prodigious height; all the vessels at the Belize blown on shore; salt spray was carried inland 5 miles. 1779, August 8, hurricane suddenly advanced on New Orleans; the naval squadron of Governor Galvez of Louisiana destroyed. 1780, August 24, a hurricane more furious than that of 1779. 1781, August 23, hurricane desolates Louisiana; Mississippi Delta entirely inundated. Between 1740 and 1800, there were fifteen destructive storms. In 1813, August 19, very destructive hurricane on the Gulf coast. 1819, August 25-28, great destructive hurricane in Louisiana and Alabama. 1852, August 23-25, hurricane and highest flood ever known, except that of 1772. 1856, August 19, hurricane swept the coast of Louisiana, but was not particularly severe on the Alabama and Mississippi coasts; Lost Island was submerged and 300 lives lost. 1860, August 11, storm at Mobile; the high-water mark was 18 inches lower than that of 1852. On September 15, of the same year, another storm, whose high-water mark was 12 inches lower than that of 1852; this is the only instance in this century of two autumnal floods in the same year. 1870, July 30, storm at Mobile, the earliest hurricane on record at that place; the high-water mark was about the same as that of 1860. 1888, August 18-20, southeast gale at Mobile, with very high tide about equal to that of 1860. During the storm of the present October, 1893, the water at Mobile rose 3 inches above the flood line of 1852, and all recognize it as the worst that has hitherto been experienced here.

The observer at Pensacola reports:

October 3d, a severe storm struck this place about 4.45 a. m. Rain began at 5.20, accompanied by high wind attaining a maximum velocity of 66 miles southwest at 3.45 p. m. From 6 to 10 a. m. the average hourly velocity was 34 miles, and from 10 a. m. to noon 40 miles per hour were registered. Considerable damage was done, the greatest occurring along the water front. Railroad communication was entirely cut off by washouts, and great damage was done to shipping.

The hurricane center moved slowly northeast over Georgia to Cape Hatteras, and seems to have been dissipated on the 5th; violent winds, heavy rains, and local storms attended its progress through the south Atlantic states.

The observer at Savannah, Ga., reports:

October 3d, rain began early morning and continued at intervals until 6.50 p. m. Between 12.30 and 1 p. m. a funnel-shaped cloud was reported about one mile east of the station. It was composed of innumerable streamers extending downward to within a few feet of the ground. Its rotary motion was from right to left. The time elapsing from its appearance to disappearance was about 4 minutes, and its course was from southeast to north-

northwest. Débris was thrown toward the west and northwest. Heavy rain preceded the cloud. The stern of an iron-clad steamship, moored at the wharf, was blown 20 feet.

IV.—This depression passed from Athabasca on the 2d eastward over Manitoba on the 4th, at which time the area of low pressure had extended far southward and a new center (VI) began in Colorado.

V.—This slight depression occurred only on the maps of the 3d moving from Kentucky to Lake Erie, and represented the northern end of a large area in the southern portion of which lay the center of the hurricane called low No. III.

VI.—This area was central in Kansas on the afternoon of the 4th and was at that time at the southern end of the larger area of which low No. IV was in the northern portion; the latter possibly filled up while the former (VI) increased rapidly as to the depression and the attendant winds and rains. This center passed over the Lake region on the 6th, and is described fully in the first Lake Storm Bulletin of 1893. The southerly winds on Lakes Huron and Erie and the northwest winds on Lakes Michigan and Huron were particularly severe.

VII.—This was developing in British Columbia on the 5th and formed the northwest portion of the depression whose southeastern part was occupied by low No. VI. On the 7th, in the morning, No. VI was north of Lake Huron and No. VII in Manitoba, after which they cannot be traced separately; they either filled up simultaneously or moved far northward beyond our stations.

VIII.—This appeared as a well-defined low pressure in British Columbia on the morning of the 7th, while Nos. VII and VI then existed far to the eastward. It had apparently moved very rapidly eastward from the Pacific and so continued, with remarkable rapidity, in a due eastward course, until on the 10th it disappeared over the Gulf of Saint Lawrence.

IX.—On the 8th, while No. VIII passed from Manitoba to Lake Superior and normal or rather high pressures prevailed from the 45th to the 30th parallels, temperatures rose decidedly at the Rocky Mountain central plateau stations, the pressure began to fall, and an ill-defined low (No. IX) developed; this continued moving slowly northeastward until the afternoon of the 10th when its northern end began to fill up, and disappeared, while its southern end developed as a well-marked low area in Kansas; this moved eastward to Illinois on the 12th and entirely disappeared in Tennessee by the morning of the 13th, in the presence of the West India hurricane that was then off the coast of North Carolina.

X.—This storm was described at the time in the Lake Storm Bulletin No. 2 of 1893. From subsequent data it appears that the early history of this hurricane is even at present very imperfectly known.

The reports from the "Ida" show a high sea October 1st-3d from the southeast, with gloomy weather, at about latitude 15°, longitude 43° to 45°. I locate the hurricane center on October 3d, Greenwich noon, at approximately N. 18°, W. 45°, therefore there is some discrepancy in relation to the swell from the southeast, as reported by the "Ida".

The reports from the "Catalonia" show that a disturbance prevailed on October 3d and 4th in latitudes 19° to 20° and longitudes 48° to 50°, and I locate the hurricane center October 5th, Greenwich noon, at approximately latitude 18°, longitude 49°. On the 5th, at noon, the "Catalonia" was near the center.

The "John B. Coyle" was near the center from noon of 6th to 3 a. m. of 7th, and I locate the center at noon of the 7th as approximately 21° N., 58° W. The center passed northeast of Nassau in the early morning of the 11th, and the steamer "Ciudad Condal" passed through the center at 9 a. m. of the 12th, at which time the center was approximately latitude 27°, longitude 79°.

The following reports from Antigua and Dominica show the slow advance of this hurricane as it passed north of those islands. It should be remarked that the suggestion by the observer at Dominica, that his ocean swell from the west on October 6th was due to the action of a storm in the Gulf of Mexico on October 2d, seems entirely inadmissible, and the editor thinks it more probable that this and similar instances in the West Indies are illustrations of the fact observed by him at the Island of Ascension, *i. e.*, that a heavy swell on the east side creeps around to the other side and there produces rollers that appear to come in from the west. A similar but much feebler illustration of wave phenomena has also been observed by him at Barbadoes.

Government Laboratory, Saint Johns, Antigua. Barometer (corrected and reduced) September 30th, 29.94 but fell steadily to October 5th, 29.70, and October 6th, 29.68 all day, the wind from southwest, force 3 and 4; minimum 29.66 at 3 p. m., southwest, force 5, and stayed low throughout the 7th, south-southwest from 6 diminishing to 4. Rose steadily 8th, 9th, 10th to 29.98 on the 12th, east wind. Large waterspouts on the 10th northwest of Saint Johns from 1-2 p. m. and thunderstorm in the evening working up from the south and west. During the 6th the sky covered with thin haze.

Government House, Roseau, Dominica. Ever since October 1st most unusual weather, very hot; light northerly winds; highly colored sunsets; no rain, abnormal low barometer steadily, falling to minimum, 29.77, on the morning of the 6th, after which it began clearing and the ocean swell was from the westward; the reporter thinks this depression and swell must have come from the storm which was violent in the Gulf on October 2d; he states that on account of the high hills and mountains on the east side of the island the direction of the winds can only be judged of from the apparent movement of the clouds. His own position is on the west or leeward side of the island, having these hills and mountains on the east. At his location the sea is invariably calm when the wind is in the usual direction; his barometer is 90 feet above sea-level. His total rainfall for September is 10.79 inches on 24 days out of 30; the total rainfall for the year up to date is 66.14.

The observer at Santiago de Cuba states that: "The hurricane that originated in the Antilles moved north and was first heard of off Antigua; was north-northeast of Saint Thomas on October 7th in the morning, the outward spirals having touched the hilly lands of Santo Domingo caused the hurricane to pass so far north."

This last report illustrates the impossibility of locating the center and path of the hurricane from a few local reports; the present storm undoubtedly originated a long way east of the Antilles, and was at no time very near those islands or the Island of Antigua; the influence of the hilly island of Santo Domingo on the track of this hurricane is also very much exaggerated; cases are on record in which a hurricane center passing directly over Puerto Rico, Santo Domingo, or Cuba is somewhat deflected by the islands, but when the center, and in fact the whole whirlwind, is over the free ocean the influence of distant islands must be inappreciable.

M. Carmena, captain of the steamer "Ciudad Condal", reports the position of his vessel in the neighborhood of this hurricane center on the 11th and 12th of October. The position of the vessel was, on the 11th, noon, N. 25° 57', W. 79° 59'; 12th, noon, N. 27° 16', W. 79° 41'; 13th, at noon, N. 27° 20', W. 79° 5'. On the first date, 11th, at 9 p. m., the hurricane center was 70 miles east-northeast from the vessel. On the 12th, at 4 a. m., it was 50 miles east of the vessel, and on the 13th, at 4 p. m., it was 30 miles southeast. The barometer at these times read 748, 740, and 729 millimeters, respectively, not corrected for temperature (24° C.); the winds were north-northwest force 9, north-northwest, 11, and southwest, 11; the average speed of the hurricane center was 6 miles hourly toward the N. 70° W. The vessel had a speed somewhat greater; the maximum velocity of the wind was about 80 miles per hour. The vessel, notwithstanding the head wind from north-northwest, gained on the cyclone center and passed ahead to the northward of its track; she was in the Gulf Stream, being on her way from Habana to New York. It is probable that the center of the hurricane was farther from the vessel than the figures above given would indicate.

The high water caused by the easterly winds on the south Atlantic coast was very severe and caused much damage. The hourly record of the height of water, the wind, and other



elements as furnished by Gen. E. P. Alexander, of Georgetown, S. C., is given in the subsequent section, "Notes by the Editor," but the following extract from a letter by the same gentleman is of interest:

The gale of 1822, September 27 and 28, is the most memorable of all prior to 1893 among the traditions of this section, the loss of life being very great for those days; forty were drowned at North Inlet; twenty on Murphys Island, and probably in all 200 at various points along the coast. The storm began about 10 p. m. of the 27th and was all over by daylight of the 28th. After that gale several planters built storm towers of brick for their slaves to take refuge in. Records of high water in previous gales have been preserved by means of notches on trees, and by comparison it appears that the high water of October 13-14 exceeded that of September, 1822, and also that of August 28, 1881, by nearly 3 feet. It exceeded that of August 27, 1893, by at least 2 feet 4 inches. I have had a level taken from the inside of the North Island lighthouse tower, where the water mark is least likely to be obscured by wave action, and the level reached was 11.3 feet on the U. S. Engineer's tide gauge, whose zero mark is 1 foot below ordinary low water; this would give 10.3 feet above ordinary low and 6.8 above ordinary high water, which is 4.5 on that gauge. The popular report is that the water rose on Magnolia Beach, a sandy peninsula about 25 miles northeast of Georgetown, 6 feet above the August gale, but this needs to be verified by an expert. What between the two gales, August and October, and one or two freshets in the river, the average production of rice in all this region will hardly exceed one-sixth or one-seventh of the estimated crop. The total loss of life in this vicinity in the October storm is 22 and the loss of property at least \$250,000. Almost worse than the physical losses to the fisherman, and those who were much exposed, is their demoralization and discouragement, and loss of confidence. They are prepared to believe all sorts of absurd predictions of more storms coming, which are circulated among them without any one knowing who is responsible for them.

At Jupiter, Fla. (26° 56' N.), rapidly falling barometer and north winds backing to northwest began on October 11th. Heavy rain began 9.27 p. m., 11th, ending 1.22 p. m., 12th. The wind reached a maximum velocity of 72 miles from the west at midnight, 11th, to 2 a. m., 12th. Great damage was done to docks, vessels, crops, and houses. Three bodies were washed ashore in this vicinity. For many miles along the Indian River the sea broke over the peninsula, raising the river to a point never before attained. Orange groves on Indian River were injured and great damage was done to farms. From Titusville to Lake Worth (26° 40' N.), a distance of 150 miles, nearly all docks were washed away.

At Melbourne, Fla. (28° 6' N.), the water was several feet higher than it has been for several years; the storm was by far the worst since the great gale of 1880.

The observer at Titusville, Fla. (28° 35' N.), reports as follows:

October 11th at 8 p. m., was blowing at the rate of 52 miles steady, with a maximum of 60 miles. As the night advanced the conditions became more threatening. At 12.05 a. m. the anemometer cups were blown away, and there were several heavy squalls during the night that must have been between 80 and 90 miles per hour. Rain began 9.10 p. m. of 11th, and at 8 a. m. of 12th the amount in the gauges measured 2.20 inches. The continued north and northwest winds drove the water back from the western shore of the Indian River farther than ever before. At the end of the steamboat dock, where there is generally 6 to 8 feet of water, the bed was perfectly dry for about  $\frac{1}{2}$  of a mile. Rain ended 5.55 p. m. of 12th. One house was blown down and several small buildings moved from their foundations, and great damage to electric wires. The orange crop is badly damaged, and in some localities the ground was covered with the green fruit; two small steamers and a sailing vessel were wrecked and several docks blown away. Great damage was done to shipping.

The following extract is from a letter from Mr. E. S. Conant, keeper of the Musquito Lagoon House of Refuge of the U. S. Life-Saving Service (N. 28° 50'), to Commander C. D. Sigsbee, U. S. N., dated October 14th:

The storm that has just passed this station was far more severe at this place than the one of August 26 and 27, and the indications of its approach were observed for a longer period of time than were those of the approach of that storm. The sea was much higher than has ever been observed here to my knowledge. The surf by its peculiar action cutting away the bank in front of the station and several seas washing entirely under the house, which is situated about 80 yards from high-water mark. Timbers that have lain on the beach ridge for years were caught up and thrown 40 or more yards higher than they had before lain. Some of these were about 60 feet long and 2 feet square, showing that it was no small wave that handled them. The weather vane I use for getting the true direction of the wind is fastened permanently to a rod which passes down into the house, and the motion is there shown by

a dial and index hand. This gives me a very true direction of the wind, as the house is situated on a narrow neck of land, with no trees nearer than 1 $\frac{1}{2}$  miles.

I regret that I have been unable to obtain even the loan of an instrument to measure the velocity of the wind.

*Jacksonville, Fla.*—The northeast wind prevailed from October 7th to 11th. On the 11th at standard low tide the water was within 10 inches of the standard high tide; on the 12th, at 7 a. m., the water had risen still higher and covered the sea wall of the central basin, and at 8 a. m. was combing over the sea wall north of Fort Marion; 12th, at 10.30 a. m., the water reached its highest point, 12 inches above the sea wall, and the streets of Saint Augustine were inundated. The gale continued unabated from the north until 4 p. m., Thursday, 12th; the next regular high tide was at 11.30 p. m., but by 6 p. m. the wind had veered to northwest; the heavy rain ceased at 9 p. m. This gale and flood were said to be worse than those of the Vera Cruz, or of any other storm known to have visited Saint Augustine. Mr. J. S. Masters, one of the oldest residents, says that the tide was the highest that he has known since 1824, when he rowed a boat into the hallway of the old Mickler house on Charlotte street. According to the measurements of the United States office of River and Harbor Improvements the outer end groin, near Davidson's house, on Anastasia Island, is 3 $\frac{3}{4}$  feet above mean high-water mark and the sea wall in the basin in front of the Plaza is 5 feet above mean high-water mark. The high water of October, 1893, not calculating the swell of the waves, rose at least 12 inches above the top of this sea wall.

*Wilmington, N. C.*—The storm arrived on time in accordance with the predictions of the Weather Bureau; the maximum violence of the wind was between 11 a. m. and 2 p. m. October 13th; velocity 56 miles per hour. The tide and overflow were the highest ever known here, and were much worse than that of August. At Southport the wind velocity reached 80 miles at 11.30 a. m.

*Charleston, S. C.*—The prediction of the Weather Bureau, that while the storm might pass close to Charleston it would do no material damage, has come true, and October 13, 10.20 a. m., the wind is decreasing and there is no rain.

*Raleigh, N. C.*—Barometer began to fall rapidly during the early morning of the 13th, and continued to fall until 3.20 p. m., when it read 28.67, being the lowest on record at this station. A gale began at 1-1 a. m. and continued until 7.30 p. m.; the most violent gusts occurred between 2 and 3 p. m.

The following account of this storm is taken from Lake Storm Bulletin No. 2:

By the evening of the 9th its approach was indicated by reports from Nassau, in the Bahamas, and southern Florida. On that date information signals were ordered on the Florida and east Gulf coasts. On the morning of the 10th brisk and high northerly winds were reported at Nassau, and signals for northeast gales were ordered at Key West and Jupiter, Fla.

By the evening report of the 10th the wind freshened to a gale at Jupiter and storm northeast signals were ordered for all Florida stations and information signals were displayed as far north as Wilmington. On the morning of the 11th the storm was apparently central east of the Bahamas and the barometer was falling rapidly over the Bahamas and at Jupiter. Northeast storm signals were ordered on the Atlantic coast from Savannah to Hatteras. Heavy southeast swells were reported on the south Atlantic and New Jersey coasts during the 11th. At noon northeast storm signals were ordered as far north as Chesapeake Bay, and information signals thence to Eastport. During the 12th severe northeast gales and heavy rains prevailed on the south Atlantic coast, and the barometer fell rapidly.

On the morning of the 13th the storm center reached the South Carolina coast, and a barometer reading of 28.88 was reported at Charleston at 6.45 a. m.; at this report the conditions indicated that the storm would move northward over the interior through the Carolinas and the middle Atlantic states. Northeast storm signals were ordered for all stations on the middle Atlantic and New England coasts. Special noon reports showed the storm central midway between Wilmington and Charlotte, N. C.; at that time northeast storm signals were ordered for Lakes Ontario and Erie and southern Lake Huron. Special warnings were sent to all Weather Bureau observers in the middle Atlantic states and New England, and observers from southern New England to Maryland were authorized to use the telegraph at their discretion in distributing these warnings in the most effectual manner possible.

Special warnings were also sent to postmasters on the New Jersey coast, and to telegraph and railroad officials in the line of the storm.

The evening report of the 18th showed the storm central over northeastern North Carolina, the storm center having passed Lynchburg about 5 p. m., where a barometer reading of 28.88 was recorded. The center passed west of Washington, D. C., about 9 p. m. and by the morning of the 14th it had crossed Pennsylvania and western New York, and was central north of Lake Ontario, a barometer reading of 28.74, the lowest noted during its passage, was reported at Toronto. Northwest storm signals were displayed at all lake stations except Duluth, and heavy westerly gales prevailed over the Lake region until the morning of the 15th. During the 15th the storm disappeared in the direction of Labrador. From the appearance of this storm east of the Bahamas on the morning of the 11th, its course was accurately forecasted and ample warnings given throughout its entire path as to its destructive character.

XI.—This area, like No. VIII, first appeared on the coast of British Columbia on the morning of the 11th; it moved rapidly eastward while No. IX was developing in Illinois, and on the 12th very low barometer prevailed in Assiniboia and Saskatchewan, and probably to the northward, but the center of this depression had disappeared by the morning of the 13th. It is impossible, at present, to say whether it disappeared by simply filling up, as was the case with area No. IX on that same day in Tennessee, or whether it simply changed its course of southeastward advance into a north-eastward movement, as would seem to be plausible, judging from the analogy of those storms that descend far enough southward over the United States to have their tracks accurately mapped out.

XII.—Low area No. XI was followed by an area of high pressure moving southeastward over the Rocky Mountain plateau region, following which low No. XII appeared in Alberta on the afternoon of the 14th, while low No. X was central near Ottawa. No. XII moved slowly southward and diffused over a large area, until on the afternoon of the 16th it may be described as being the eastern angle of a depression that extended from North Dakota southwestward to the Gulf of California and northwestward to Athabasca. It then separated from these longer arms and moved northeastward until it disappeared in Manitoba on the 18th.

XIII.—The preceding low was again followed by an area of high pressure which from the 17th to the 20th advanced southeastward from British Columbia over the Rocky Mountain plateau; this was followed by low No. XIII which appeared on the afternoon of the 20th in British Columbia and moved rapidly eastward until, in the afternoon of the 21st, it was central in Manitoba. But at this time, like its predecessor, the general depression to which it belonged extended southwestward to the Gulf of California, and the morning map of the 22d shows that an extensive area of high pressure had advanced southward over Alberta and Assiniboia, almost entirely obliterating the depression of the previous map, instead of which we have now a trough (bounded by the isobars of 29.80) extending from Lake Superior southwestward to Colorado and thence westward to Oregon and northern California. The map of October 22d, p. m., shows this trough of 29.80 in nearly the same locality, inclosing a trough of 29.70 or less, out of which developed low area XVI.

XIV.—By XIV we designate the area of low pressure which frequently during October, as during previous months, has stretched north and eastward over Arizona. It should undoubtedly be considered as an arm or extension of some larger low pressure that exists permanently over the Pacific Ocean near the coast of Mexico and the peninsula of Lower California. It frequently exhibits a tendency to stretch far to the northeastward, while the low areas that descend the eastern Rocky Mountain slope show an equal tendency to stretch southwestward and make connection with the depression in Arizona or northern Mexico. Such extensions occurred, for instance, on the 1st of October, when a storm (low area No. I) was developing in the Gulf of Mexico and a high barometer was descending from Oregon; again, on the 4th, low No. VI

developed in Kansas and New Mexico and pressure was low at Yuma while a high area began to advance from Oregon southeastward to Texas; again, on the 9th, while low No. IX developed on the Rocky Mountain plateau it finally stretched from Arizona to Lake Superior, but a high area moved eastward over California, and being subsequently reinforced covered the greater part of the Rocky Mountain plateau on the morning of the 13th, obliterating the well-marked low Nos. XI and XIV; on the 13th this high area became the principal feature of the map west of the Mississippi Valley, while the hurricane, low No. X, was the principal feature east of that river. On October 15th low area No. XII was central at the northern end of a depression that extended southward over Arizona and the Gulf of California, and during the 16th to 20th this long trough was followed by a high coming over Oregon and extending southeast to the Mississippi Valley. On the 21st this high was again followed by a low area reaching from the Gulf of Mexico to Athabasca, with low No. XIII at its northern end. During the rest of the month lows in the northwestern portion of the map did not generally form a close connection with the lows at the head of the Gulf of California, but were apparently prevented by the very prompt eastward movement over California and Oregon of the areas of high pressure from the Pacific Ocean.

We may, therefore, summarily describe the phenomena for the whole month as consisting of alternate formations or tendencies to form troughs and centers of low pressure from the Gulf of California to Alberta, followed by the more or less prompt and decisive advent of areas of high pressure moving eastward over the region intermediate between these extremes. The average pressure for the month will, therefore, be low in Alberta and in Arizona, but rather higher in the intermediate region over which the centers of the high areas have moved eastward.

XV.—As above stated, the country west of the Mississippi was dominated by an area of high pressure from October 13th to 14th, and on the 15th this area was central in the Ohio Valley; on the 16th frosts and northerly winds prevailed in the Gulf States. Undoubtedly this high pressure with northerly winds extended southward over the whole Gulf of Mexico during the 16–17th, and it is not likely that this would have been the case if there had not been a decided deficit of pressure existing still farther to the southward either in Mexico or the Caribbean Sea, or possibly even on the Pacific Ocean south of Mexico. Whatever may have been the ultimate cause of this extensive southward movement of the lower layer of the atmosphere, one of its first results must have been the formation of clouds, rain, and occasional whirlwinds on the coasts of Mexico, Guatemala, and Cuba, and in the Gulf waters themselves. By the 18th this region of cloud and rain had extended northward to our Gulf coasts, the northerly winds became more decidedly easterly, and the barometer began to fall at Nassau and Key West. The conditions were at that time such as generally precede the advance of a hurricane moving westward from the West Indies, but no reports of such hurricanes have reached us. On the 21st, however, a storm-center was certainly central in the afternoon north of the Bahamas, which may very plausibly have been developed as a well-defined whirl for the first time on that day. It moved rapidly northward, becoming a gale on the North Carolina coast on the 22d; it then swerved a little to the west and disappeared in Maryland on the 23d.

XVI.—On the 22d low area XIII had become converted into a long trough, as above described. The western end of this had by the morning of the 23d become an oval depression (XVI) reaching from Kansas to Minnesota; it moved northeastward into Ontario, and disappeared on the 25th.

XVII.—This depression is first well defined on the morning of the 25th and must for the present be considered as origi-

nating in the warmer easterly winds that were then blowing toward Colorado in the rear of the high area that had just passed on to the Lake region. It developed rapidly during that day but subsequently moved northeastward as a long trough and disappeared on the 27th.

XVIII.—This depression suddenly appeared on the afternoon of the 25th in Athabasca and Alberta, while a decided high area was advancing toward Oregon. The low pressure moved rapidly eastward at the northern boundary of our map; brisk and high northwest winds with snow succeeded it in the Lake region; it disappeared on the 29th at the mouth of the Saint Lawrence River.

XIX.—This depression appeared on the afternoon of the 29th north of Assiniboia; it moved southeastward, passing over Manitoba on the morning of the 31st.

XX.—The maps of the 29th–31st show that the high pressure that was moving from the Mississippi Valley eastward was, as in the previous case of low No. XV, attended by northeast winds

and rain in southern Florida and the Gulf of Mexico, and, as in that case, so also here, local whirls existing far to the southward could develop into larger storms. On the 29th and 30th this disturbance, which had not yet assumed the form of a large horizontal whirlwind so far as shown by the daily weather map, appeared to the observer at Musquito Lagoon, Oak Hill, Fla., N.  $28^{\circ} 51'$ , W.  $80^{\circ} 46'$ , as a distant bank of clouds, which he describes as follows:

On October 29th a bank of clouds at midnight looked dark and threatening in the distant southeast. This bank moved further away and was due south during the 30th, and disappeared during the 31st in the southwest. The barometer remained high during the whole; the wind was north-northeast on the 29th; northeast on 30th; northeast, force 9, on 31st; and east-northeast, force 5, on November 1st. But little scud accompanied this storm as compared with October 10–14th.

Probably the bank of clouds thus observed in the distant south represents the location of the northern edge of the rain area but not the location of a revolving storm.

### NORTH ATLANTIC STORMS FOR OCTOBER, 1893.

[Pressure in inches and millimeters; wind-force by Beaufort scale.]

The paths of storms that passed over the western portion of the north Atlantic Ocean are shown on Chart I, so far as can be traced from information received up to the 25th of November, through the co-operation of the Hydrographic Office, U. S. Navy, and the "New York Herald Weather Service."

The normal pressure for October over the north Atlantic Ocean, as shown by the international simultaneous meteorological observations, is highest, 30.10 (764), in two large ovals between parallels N.  $25^{\circ}$  and  $40^{\circ}$ , and central, respectively, on meridians W.  $30^{\circ}$  and  $85^{\circ}$ . The pressure is lowest, 29.70 (754), between Iceland and Greenland. As compared with September the normal pressure for October is about 0.05 less in the North Atlantic between parallels N.  $40^{\circ}$  and  $50^{\circ}$ , and meridians W.  $30^{\circ}$  to  $60^{\circ}$ .

As compared with the annual normal pressure for the northern hemisphere, the monthly normals for October show a deficiency of 0.05 from Central America eastward over the West Indies to the meridian of  $35^{\circ}$  W., and between the parallels of  $15^{\circ}$  to  $30^{\circ}$  N.

The tracks of storms for October may be classified as (1) those that begin in the Atlantic south of the parallel of  $20^{\circ}$  and after moving westward turn to the northeast; (2) those that pass from the Pacific coast between parallels  $45^{\circ}$  and  $55^{\circ}$  eastward over New England and the Canadian Provinces; (3) those that originate off the New England and Canadian coasts and pass northeastward to Great Britain and Norway. Occasionally one of the first or second class continues long enough to pursue the path followed by the third class, but this is rare.

The region of the greatest frequency of storm-centers extends from Lake Superior to the lower Saint Lawrence, where an average of 5 tracks per month cross over each space of  $5^{\circ}$  in latitude and longitude during October.

The average velocity of movement of storm-centers for October, in statute miles per hour, is 30 for the United States, when moving eastward, and 19 for the Atlantic Ocean. Before recurving the West Indian storms move at the rate of 12 miles per hour westward, and after recurving at the rate of 28 miles northeastward, but during the recurve at the rate of only 9 miles per hour. The simultaneous charts of the northern hemisphere for 1878 to 1887 show that during the ten years only one storm in the month of October could be traced across both the North American continent and the Atlantic Ocean.

During October, 1893, the following storms have been traced over portions of the north Atlantic Ocean; the centers are located for Greenwich noon by international simultaneous observations, as follows:

A. The center of this storm is located, approximately, on Chart I, for the 29th and 30th of September and for the 1st and 2d of October, as it passed northeastward some distance from the coast of Nova Scotia. The lowest barometer reported was 29.18 on October 1st, but the low pressure filled up by the 4th and the winds died away.

B. This is the continuation of the storm (F) in September; it was central in Scotland on the 1st, and extended slowly south and east until, on the 6th, two centers of low pressure and revolving winds existed, the one northeast of Scotland and the other near the Bay of Biscay, both of which continued until the 9th, after which the southern one disappeared and the northern one moved slowly northeastward, disappearing in Finland on October 15th.

C. This represents the end of the history of the incipient hurricane (low area No. III of the United States). This storm, which was a small violent whirl in the Gulf of Mexico on October 1st, passed northeastward over the south Atlantic states, and on October 5th (Greenwich noon) was central at about N.  $35^{\circ}$ , W.  $70^{\circ}$ ; it appears to have filled up rapidly on the 6th, and it has not been traced any further.

D. This is the Atlantic hurricane (low area No. X of the United States) whose track is given on Chart I as far as our limited knowledge allows. It was evidently a well-developed hurricane on the 5th, moving slowly westward at about N.  $15^{\circ}$  or  $20^{\circ}$ ; the general depression of which it was a part also included at that time the storms A and C, and covered the whole West Indies and Caribbean Sea. The storm-center moved steadily westward until it was near the Bahamas on the 12th, it then turned northward and disappeared in Labrador on the 15th.

E. The low area No. VIII of the United States, having its center far north of Canadian stations, moved east-southeast on the 10th, and at noon an extensive area of low pressure, with several subsidiary centers, extended from N.  $35^{\circ}$ , W.  $65^{\circ}$  northeastward over Newfoundland; the principal center being near the southern coast of that island. On the 11th, at noon, this was at N.  $47^{\circ}$ , W.  $45^{\circ}$ . On the 12th, at noon, N.  $50^{\circ}$ , W.  $42^{\circ}$ , barometer 28.85. On the 13th, N.  $49^{\circ}$ , W.  $40^{\circ}$ . On the 14th, N.  $50^{\circ}$ , W.  $30^{\circ}$ , but stretching northeast as a trough whose other secondary center was about at N.  $60^{\circ}$ ,